NATURAL RESOURCES CONSERVATION SERVICE
PACIFIC BASIN AREA
CONSERVATION PRACTICE STANDARD

IRRIGATION WATER CONVEYANCE, LOW-PRESSURE, UNDERGROUND, PLASTIC PIPELINE

(Meters, Feet)
CODE 430EE

DEFINITION

A pipeline and appurtenances installed in an irrigation system.

PURPOSE

- To prevent erosion.
- To prevent loss of water quality.
- To prevent damage to the land.
- To make possible the proper management of irrigation water.
- To reduce water conveyance losses.

CONDITIONS WHERE PRACTICE APPLIES

All pipelines shall be planned and located to serve as an integral part of an irrigation water distribution or conveyance system. The system shall be designed to facilitate the conservation use and management of the soil and water resources on a farm or group of farms.

The water supply and quality and rate of irrigation delivery for the area served by the pipeline shall be sufficient to make irrigation practical for the crops to be grown and the irrigation water application methods to be used.

Plastic pipelines installed according to this standard shall be placed only in suitable soils where the bedding and backfill requirements can be fully met.

PLANNING CONSIDERATIONS

WATER QUANTITY

Effects on the water budget, especially on infiltration and evaporation.

Effects on downstream flows or aquifers that would affect other water uses or users.

Potential use for irrigation water management.

Effects of installing a pipeline on vegetation that may have been located next to the original conveyance.

WATER QUALITY

Effects of installing the pipeline (replacing other types of conveyances) on channel erosion or the movement of sediment and soluble sediment-attached substances carried by water.

Effects on the movement of dissolved substances into the soil, percolation below the root zone or to ground water recharge.

Effects of controlled water delivery on the temperatures of water resources that could cause undesirable effects on aquatic and terrestrial wildlife habitats.

Effects on wetlands or water related habitats.

Effects on the visual quality of water resources.

DESIGN CRITERIA

Working Pressure. The pipeline shall be designed to meet all service requirements without a static or working pressure, including hydraulic transients, at any point greater than the maximum allowable working pressure of the pipe used at that point. The static or working pressure of the pipelines open to the atmosphere shall include freeboard.

Maximum allowable working pressure for the low head plastic irrigation pipe shall be 15.24 m (50 ft) or 152 kPa (22 psi).

Pipelines constructed of 345 kPa (50 psi) plastic irrigation pipe or the IPS pipe covered

by this standard shall have a working pressure no greater than 345 kPa (50 psi).

Plastic pipeline requiring a working pressure greater than 345 kPa (50 psi) shall be constructed according to the requirements specified in 430-DD of this standard.

Plastic pipe pressure rating normally is based on a water temperature of 23 degrees C (73.4 degrees F). Factors for adjusting allowable working pressure for higher water temperatures are given in table 1.

Table 1. Pressure rating factors for PVC and PE pipe for water at elevated temperatures.

Temperature		PVC	PE
°F	(°C)		
73.4	(23)	1.00	1.00
80	(27)	0.88	0.92
90	(32)	0.75	0.81
100	(37)	0.62	0.70
110	(43)	0.50	---
120	(49)	0.40	---
130	(54)	0.30	---
140	(60)	0.22	---

NOTE: To obtain the pipes reduced pressure rating because of water temperature greater than 73.4 deg. F, multiply the normal pressure rating by the appropriate factor from the table.

Friction Losses: For design purposes, friction head losses shall be no less than those computed by the Hazen-Williams equation, using a roughness coefficient, C, equal to 150. See NEH Part 650 - Engineering Field Handbook (EFH) Chapter 3.

Flow Velocity. The full-pipe design water velocity in the pipeline when operating at system capacity should not exceed 1.524 m/s (5 ft/s).

Capacity. The design capacity of the pipeline shall be based on whichever the following criteria requires the larger amount of water:

1. The capacity shall be sufficient to deliver the volume of water required to meet the peak-period consumptive use of the crop or crops to be irrigated.
2. The capacity shall be sufficient to provide an adequate irrigation stream for all methods of irrigation planned.

Outlets. Appurtenances to deliver water from pipe system to the land, to a ditch or a reservoir, or to any surface pipe system shall be known as outlets. Outlets shall have adequate capacity at design working pressure to deliver the required flow to (1) the hydraulic gradeline of the pipe or ditch, (2) a point at least 152 mm (6 inches) above the field surface, or (3) the design surface elevation in a reservoir.

Check Valves. A check valve shall be installed between the pump discharge and the pipeline if backflow may occur.

Stands Open to Atmosphere. Stands shall be used wherever water enters the pipeline system to avoid entrapment of air, to prevent surge pressures, to avoid collapse because of negative pressures, and to prevent the pressures from exceeding the maximum allowable working pressure of the pipe. Open stands may be required at other locations in low-head systems to perform other functions.

Stands shall be constructed of steel pipe or other approved material and be supported on a base adequate to support the stand and prevent movement or undue stress on the pipeline. Open stands shall be designed to meet or exceed the following criteria:

1. Each stand shall allow at least 1 ft. (0.3048 m) of freeboard above the design working head. The stand height above the centerline of the pipeline shall be such that neither the static head nor the design working head plus freeboard exceeds the allowable working pressure of the pipe.
2. The top of each stand shall extend at least 4 ft (1.22 m) above the ground surface except for surface gravity inlets or where visibility is not a factor. A gravity inlet shall be equipped with a trash guard.
3. The downward water velocity in the stands shall not exceed 2 ft/s (0.61 m/s). The inside diameter of the stand shall not be less than the inside diameter of the

pipeline. This downward velocity criterion applies only to stands having vertical offset inlets and outlets.

4. If the water velocity in the inlet (from the pump or water source) equals or exceeds three times the velocity in the outlet pipeline, the centerline of the inlet shall have a minimum vertical offset from the centerline of the outlet at least equal to the sum of the diameters of the inlet and outlet pipes.
5. The cross-sectional area of stands may be reduced above a point 1 ft. (30.5 cm) above the top of the upper inlet or outlet pipe, but the reduced cross section shall not be such that it would produce an average velocity of 10 ft/s (3.05 m/s) if the entire flow were discharging through it.
6. Vibration-control measures, such as special couplers or flexible pipe, shall be provided as needed to insure that vibration from pump discharge pipes is not transmitted to stands.

Sand traps, when combined with a stand, shall have a minimum inside dimension of 0.76 m (30 in) and shall be constructed so that the bottom is at least 0.61 m (24 in) below the invert of the outlet of the pipeline. The downward velocity of flow of the water in the sand trap shall not exceed 7.2 cm/s (0.25 ft/s).

Gate stands shall be of sufficient dimension to accommodate the gate or gates and shall be large enough to make to gates accessible for repair.

Float valve stands shall be large enough to provide accessibility for maintenance and to dampen surge.

Stands Closed to the Atmosphere. If pressure-relief valves and air-vacuum, valves are used instead of open stands, all requirements under "Stands Open to the Atmosphere" shall apply except as modified below.

The inside diameter of the closed stand shall be equal to or greater than that of the pipeline for at least 1 ft. (30.5 cm) above the top of the uppermost most inlet or outlet pipe. To facilitate attaching the pressure-relief valve and the air-and-vacuum valve the stand may be capped at this point or, if additional height is required, the stand may be extended to the desired elevation by using the same inside diameter or reduced cross section. If a reduced section is used, the cross sectional area shall be such that it would produce an average velocity of no more than 3.05 m/s (10 ft/s) if the entire flow were discharged through it. If no vertical offset is required between the pump discharge pipe and the outlet pipeline and the discharge pipe is "doglegged" below ground, the stand shall extend at least 30.5 cm (1 ft) above the highest part of the pump discharge pipe.

An acceptable alternative design for stands requiring no vertical inlet offset (when inlet velocity is less than three times that of the outletting pipeline) shall be:

1. Construct the dogleg section of the pump discharge pipe with the same nominal diameter as that of the pipeline.
2. Install the pressure relief valve and the air-and-vacuum valve on top of the upper horizontal section of the dogleg.

Pressure-relief and air-and-vacuum valves shall be installed on stands with nominal size pipe required to fit the valve threaded inlets.

Vents. Vents must be designed into systems open to the atmosphere to provide for the removal and entry of air and protection from surge. They shall:

1. Have a minimum freeboard of 30.5 cm
2. (1 ft) above the hydraulic gradeline. The maximum height of the vent above centerline of the pipeline must not exceed the maximum allowable working pressure of the pipe.
3. Have a cross-sectional area at least one-half the pipeline (both inside measurements) for a distance of at least one pipeline diameter up from the centerline of the pipeline. Above this elevation the vent may be reduced to 50.8 mm (2 in) in diameter.

4. These cross-sectional area requirements shall apply when an air-and-vacuum valve is used instead of a vent, but the reduced section shall be increased to the nominal sized pipe required to fit the valve's threaded inlet. An acceptable alternative is to install this valve in the side of a service outlet, provided that the riser is properly located and adequately sized. If both air-and-vacuum and pressure-relief are required at the location, the 3.05 m/s (10 ft/s) velocity criterion given under "Stands Open to the Atmosphere" shall apply to the reduced section.
5. Be located at the downstream end of each lateral, at summits in the line, and at points where there are changes in grade in a downward direction of flow of more than 10 degrees.

Air-and-vacuum Valves. An air-and-vacuum valve, which has a large venting orifice, exhausts large quantities of air from the pipeline during filling operations and allows air to reenter the line and prevents a vacuum from forming during emptying operations. This type of valve is sometimes called air-vacuum valve or air vent and vacuum relief valve. It is not continuous acting because it does not allow further escape of air at working pressure once the valve closes.

Air-and-vacuum valves installed according to the standards for "Vents" can be used instead of open vents at any or all the locations listed in (3) under "Vents".

Air-and-vacuum valves installed to standards for "Stands Closed to the Atmosphere" can be used in conjunction with pressure-relief valves as an alternative to open pump stands. A pipeline is considered open to the atmosphere if at least one stand, vent, or service outlet is unclosed or located so that it cannot be isolated from the system by line gates or valves.

The diameter of the orifice (opening that controls air flow during filling and emptying operations) of an air-and-vacuum shall equal or exceed that specified below for the appropriate diameter of pipeline.

Diameter of Orifice		Diameter of Pipe	
(in)	(mm)	(in)	(mm)
1/2	(12.7)	1	25
3/4	(19.0)	1.5	38
3/4	(19.0)	2	50
1-1/4	(31.8)	6	150
1-3/4	(44.4)	8	200
2-1/4	(57.2)	10	250
2-3/4	(70)	12	300
3-1/4	(82.6)	14	350
3-1/2	(88.9)	15	375
3-3/4	(95.2)	16	400
4	(102)	18	450

Manufacturers of air-and-vacuum valves marketed for use under this standard shall provide dimensional data, which shall be the basis for selecting and accepting these valves.

Pressure-relief Valves. Pressure-relief valves can be used on low-pressure plastic pipelines as an alternative to stands open to the atmosphere. A pressure-relief valve shall serve the pressure relief function of the open stand or vent for which it is an alternative.

Pressure-relief valves do not function as air-release valves and shall not be used as substitutes for such valves if release of entrapped air is required. Pressure-relief valves shall be used in conjunction with air-and-vacuum valves at all pump stands and at the end of pipelines if needed to relieve surge at the end of the lines.

The flow capacity of pressure-relief valves shall be the pipeline design flow rate with a pipeline pressure no greater than 50 percent more than the permissible working pressure for the pipe.

The pressure at which the valve starts to open shall be marked on each pressure-relief valve. Adjustable pressure-relief valves shall be sealed or otherwise altered to insure that the adjustment marked on the valve is not changed.

Manufacturers of pressure-relief valves marketed for use under this standard shall provide capacity tables, based on performance tests, that give the discharge capacity of the valves at the maximum permissible pressure and differential pressure settings. Such tables shall be the basis for the design of pressure setting and for acceptance of these valves.

Drainage. Provisions shall be made for completely draining if a hazard is imposed by freezing temperatures, drainage is recommended by the manufacturer of the pipe, or drainage is specified for the job. If provisions for drainage are required, drainage shall be located at all low places in the line. These outlets can drain into dry wells or to points of lower elevation. If drainage cannot be thus provided by gravity, provisions shall be made for emptying the line by pumping or by other means.

Flushing. If provisions are needed for flushing the line free of sediment or other foreign material, a suitable valve shall be installed at the distal end of the pipeline.

Thrust Control. Anchors or thrust blocks shall be provided on pipelines having a working pressure of 170 kPa (25 psi) or greater at abrupt changes in pipeline grade, changes in horizontal alignment, or reduction in pipe size to absorb any axial thrust of the pipeline. Thrust blocks may also be needed at the end of the pipeline and at inline control valves.

The pipe manufacturer's recommendations for thrust control shall be followed. In the absence of such recommendations, the following formula should be used to design thrust blocks:

For traditional units:

Where:
A = Bearing area of thrust block required (ft2).
H = Maximum working pressure (ft).

D = Inside diameter of pipe (ft)
B = Allowable passive pressure of the soil (lb/ft2).
a = Deflection angle of pipe bend.

For metric units

Where:
A = Bearing area of thrust block required (m2).
H = Maximum working pressure (m).
D = Inside diameter of pipe (m).
B = Allowable passive pressure of the soil (kPa).
a = Deflection angle of pipe bend.

Area of thrust blocks for dead ends and tees shall be 0.7 times the area of block required for a 90 degree deflection angle of pipe bend.

If adequate soil tests are not available, the allowable bearing soil pressure can be estimated from Table 2a (U.S.) and Table 2b (Metric).

Materials. All materials described and required in this standard shall meet or exceed the minimum requirements listed for materials under specifications.

PLANS

Plans and specifications for constructing low-pressure, underground, plastic irrigation pipelines shall describe the requirements for applying the practices for achieving its intended purposes.

Construction plans shall include the location of the pipeline, length of lines, size of lines, pipe material requirements, location of outlets, and location of air-relief, pressure-relief, and backflow valves. Details on meter connections (if applicable), pressure regulators, valves, risers, thrust blocks (if applicable), and other appurtenances should be included in the plans.

Construction plans for low -pressure underground plastic pipelines may be incorporated into plans for the following Pacific Basin standards: Irrigation System, Microirrigation (441), Irrigation System, Sprinkler (442), Waste Utilization (633), or Irrigation Water Management (449).

Plans shall be prepared in accordance with the NRCS Engineering Field Handbook, Chapter 5 "Preparation of Plans".

OPERATION AND MAINTENANCE

An Operation and Maintenance Plan must be prepared for use by the landowner or operator responsible for operation and maintenance. The plan should provide specific instructions for operating and maintaining the irrigation system to insure it functions properly. Minimum requirements to be addressed in the Operation and Maintenance Plan are:

1. Prompt repair or replacement of damaged components is necessary. Check to make sure all valves and air vents are set at the proper operating condition so they may provide protection to the pipeline. Remove foreign materials and vegetation that can interfere with proper valve operation.
2. Maintain backfill over pipe and maintain vigorous vegetative growth where applicable.
3. Remove debris and litter and any blockage that restricts capacity.
4. Avoid travel and tillage over pipelines.

REFERENCES

1. USDA NRCS, National Engineering Field Handbook, Chapter 3, 15.
2. USDA NRCS, Technical Release 77, Design and Installation of Flexible Conduits - Plastic Pipe.

Table 2a. - Allowable soil bearing pressure – Standard U.S. Units.

Natural Soil Material	Depth of cover to center of thrust block			
	2 Feet	3 Feet	4 Feet	5 Feet
	----- lb/ft^2 -----			
Sound Bedrock	8,000	10,000	10,000	10,000
Dense Sand and Gravel Mixture (assumed f=40 deg)	1,200	1,800	2,400	3,000
Dense Fine to Coarse Sand (assumed f=35 deg)	800	1,200	1,650	2,100
Silt and Clay Mixture (assumed f=25 deg)	500	700	950	1,200
Soft Clay and Organic Soils	200	300	400	500

Table 2b. - Allowable soil bearing pressure – Metric Units

Natural Soil Material	Depth of cover to center of thrust block			
	0.6 Meter	1 Meter	1.2 Meters	1.5 Meters
	----- kPa -----			
Sound Bedrock	383	479	479	479
Dense Sand and Gravel Mixture (assumed f=40 deg)	57.5	86.2	115	144
Dense Fine to Coarse Sand (assumed f=35 deg)	38.3	57.5	79	100
Silt and Clay Mixture (assumed f=25 deg)	24	33.5	45.5	57.5
Soft Clay and Organic Soils	9.8	14.4	19.2	24